Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Period: \_\_\_\_\_\_\_

**Whale Evolution**

**Engage: Put fossils in order**

|  |  |  |
| --- | --- | --- |
|  | Species name | Description of species. What structures (features) does it have? |
| Oldest  Most recent |  |  |
|  |  |
|  |  |
|  |  |
|  |  |

Summarize the structural (anatomical) changes in the ancestral species’ of whales. What changed between each species?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Explore: *How do we know evolution occurs?*** (PBS video)

Mammals first appear on Earth around \_\_\_\_\_\_\_\_\_\_\_\_ million years ago, on land. Mammals are warm-blooded, they give birth to living young and they breathe air. These are all \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to living on land. But whales and dolphins are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ too.

(*Phil Gingrich holding skull found in 1978.*) There are several things that strike you. One is that it is very similar in size and shape to the back of a skull of a\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. But there was something odd about this skull.

(*Phil Gingrich pointing to round protrusion from skull*.) Thought it would be a creodont. It was part of the animal’s inner \_\_\_\_\_\_\_\_\_ and it had a distinctive shape. A shape found today only found in one kind of animal \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

But 40 million years ago, the Sahara Desert used to be a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

A *Basilosaurus* lived full time in the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. *Basilosaurus* had something modern whales have long since lost. The bones were small but unmistakable: a pelvis, a \_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_ ,even \_\_\_\_\_\_\_\_\_\_\_\_\_. This whale had a complete set of \_\_\_\_\_\_\_\_\_\_\_\_\_\_ bones. It was dramatic evidence that whales had once been \_\_\_\_\_\_\_\_\_ - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ animals.

Scientists now think the earliest ancestor of whales was similar to this 15 million year old\_\_\_\_\_\_\_\_\_-like organism called *Sinonyx*, a predator which lived along the shores of an ancient sea. Perhaps its descendants found the water as source of abundant \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and a haven from \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Over millions of years front legs became \_\_\_\_\_\_\_\_\_\_\_\_. Rear legs \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Body lost fur and took on their familiar streamlined shape.

Since Gingrich’s first find known as *Pakicetus* the list of transitional whales has grown. It now includes *Ambuleocetus, Rodhocetus, Dorudon, as well as Basilosaurus.* They reveal the gradual migration of the \_\_\_\_\_\_\_\_\_\_\_\_\_\_ to the top of the head as whales adapted to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in the water.

Bones aren’t the only evidence of whale evolution. Their ancestry is also visible in the way they \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ . Fish swim by flexing their spines side-to-side. But mammals swim differently. This otter swims by undulating its spine \_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in exactly the same way that \_\_\_\_\_\_\_\_\_\_\_\_\_ do. And, as it turns out, in the same way \_\_\_\_\_\_\_\_\_\_\_\_\_\_ mammals use their spines when \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

**Elaborate: Evidence for Whale Evolution**

What structures does *Diacodexis* have that supports the theory that they are related to whales?

What structures does *Pakicetus* have that supports the theory that they are related to whales?

What structures does *Ambuleocetus* have that supports the theory that they are related to whales?

What structures does *Durodon*  have that supports the theory that they are related to whales?

What structures does *Basilosuarus* have that supports the theory that they are related to whales?

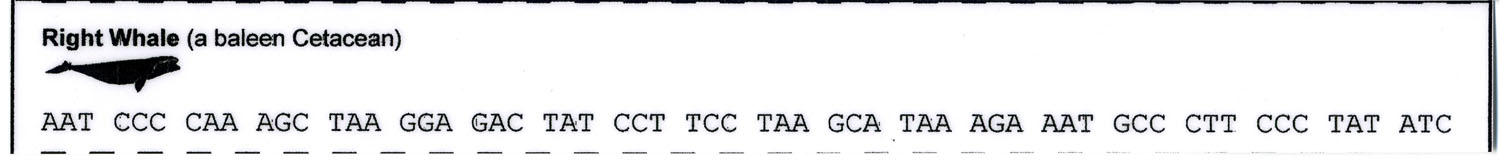
**Vestigial structures**

What structures do whales have that they no longer use? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

How does the presence of these structures support the theory of whale evolution?

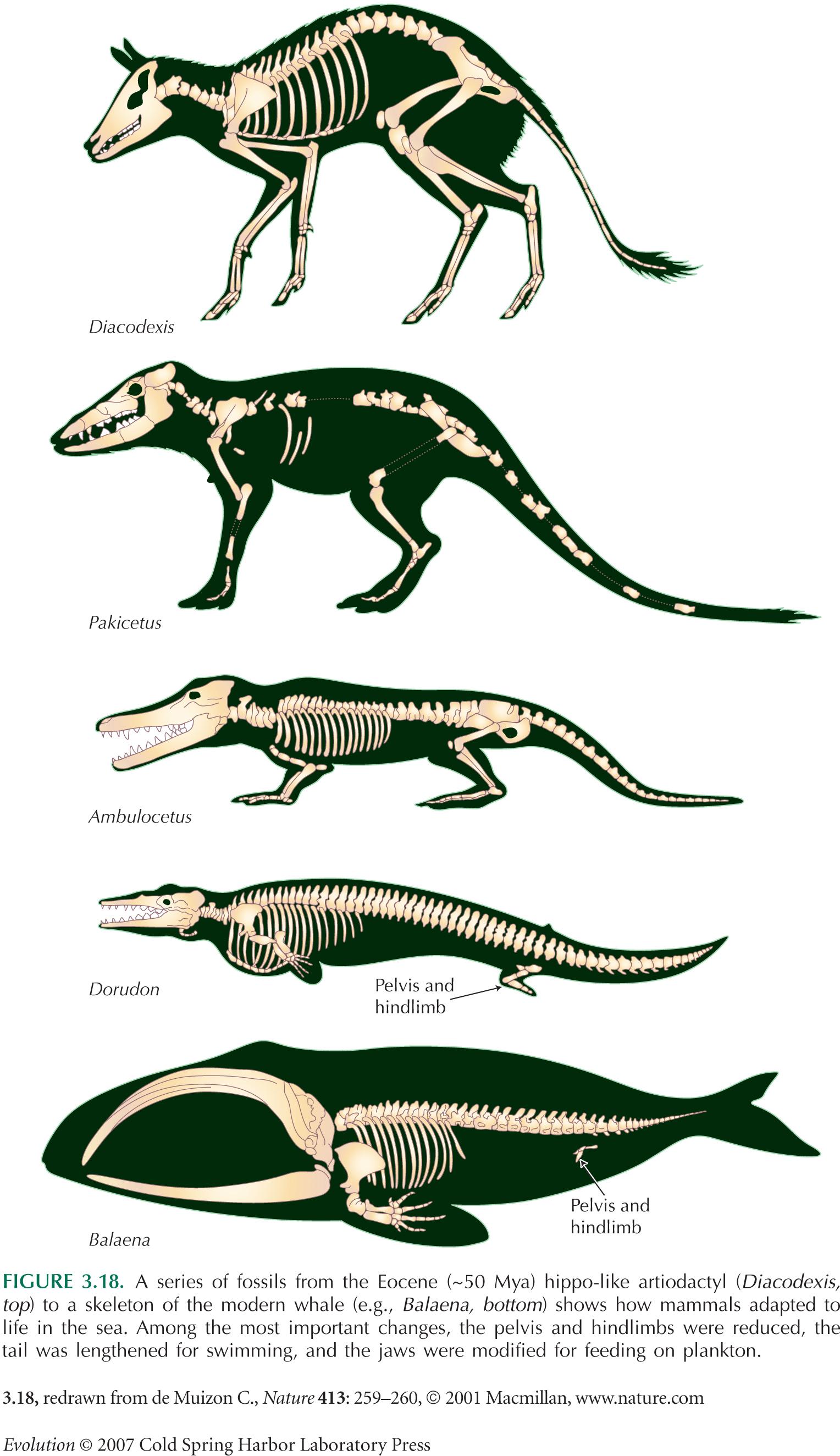
**DNA (molecular evidence)**

Circle the differences between the DNA sequences of a whale and a cow. Cows are hoofed-animals.

**
CowDNA.jpg                                                     0003AE84Macintosh HD                   BA576373:**

How many differences are there? \_\_\_\_\_ That’s \_\_\_\_\_ out of \_\_\_ which is only a\_\_\_\_\_\_\_\_\_% difference between whales’ and cows’ DNA.

How does the similarity in DNA support the theory of whale evolution?



**Diacodexis**

***Pakicetus inachus***

*Pakicetus* has key features that were transitional between [terrestrial](http://www.pbs.org/wgbh/evolution/library/glossary/glossary.html#terrestrial) mammals and the earliest true whales. One of the most interesting was the ear region of the skull. In whales, it is extensively modified for directional hearing underwater. In *Pakicetus*, the ear region is intermediate between that of terrestrial and fully [aquatic](http://www.pbs.org/wgbh/evolution/library/glossary/glossary.html#aquatic) animals.

***Ambuleocetus natans***

Another, slightly more recent form, called *Ambulocetus*, was an amphibious animal. Its forelimbs were equipped with fingers and small hooves. The hind feet of *Ambulocetus*, however, were clearly adapted for swimming. Functional analysis of its skeleton shows that it could get around effectively on land and could swim by pushing back with its hind feet and undulating its tail, as otters do today.

***Dorudon***

Dorudon, along with other basilosaurids, differed from all modern cetaceans in the shape of its head and teeth. Dorudon has a long, narrow snout, and almost certainly lacked the bulbous 'melon' that forms the spherical bulge on the facial profile of modern toothed whales.

Dorudonshares many specialized features with modern whales. The pelvis is not attached to the vertebral column, and the hindlimbs, although present, are dramatically reduced as compared to land mammals and even to earlier whales. This suggests thatDorudon was not able to 'haul out' on land like modern seals, and was fully marine, like most modern cetaceans. The shape of the vertebrae at the end of its tail is similar to that of modern cetaceans, suggesting that Dorudonwould have had tail flukes and used them to move through the ocean. The forelimb is in many ways intermediate between those of land mammals and modern cetaceans – the humerus is not as short as in modern whales, and some movement at the elbow was still possible. In modern cetaceans, the elbow is rigid and contributes to a stiff flipper.

***Basilosuarus isis***

By 40 million years ago, *Basilosaurus* -- clearly an animal fully adapted to an aquatic environment -- was swimming the ancient seas, propelled by its sturdy flippers and long, flexible body. Yet *Basilosaurus* still retained small, weak hind legs -- baggage from its evolutionary past -- even though it could not walk on land.